

# Production of highly charged ion beams from Electron Cyclotron Resonance ion sources\*

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A high density of energetic electrons is the key to further enhance the production of highly charged ion from Electron Cyclotron Resonance ion source (ECRIS). Recent ECRIS development has progressed with multiple-frequency plasma heating, higher mirror magnetic fields and better technique to provide extra cold electrons, which presumably produce a higher density of energetic electrons in an ECRIS. Such techniques greatly enhance the production of highly charged ions from ECRISs. Figure 1 graphically shows the present continuous wave mode performance of ECRISs at various intensity levels versus charge states. So far up to 300 eμA of O<sup>7+</sup> and 1.15 mA of O<sup>6+</sup>, more than 100 eμA of intermediate heavy ions for charge states up to Ar<sup>13+</sup>, Ca<sup>13+</sup>, Fe<sup>13+</sup>, Co<sup>14+</sup> and Kr<sup>18+</sup>, and tens of eμA of heavy ions with charge states to Kr<sup>26+</sup>, Xe<sup>28+</sup>, Au<sup>35+</sup>, Bi<sup>34+</sup> and U<sup>34+</sup> have been produced from ECR ion sources. At an intensity of at least 1 eμA, the maximum charge state available for the heavy ions are Xe<sup>36+</sup>, Au<sup>46+</sup>, Bi<sup>47+</sup> and U<sup>48+</sup>. An order of magnitude enhancement for fully stripped argon ions ( $I \geq 60$  eA) were also achieved. Further enhancing ECRIS performance continues to be a cost effective way to improve the capabilities of heavy ion accelerators and open up new opportunities for nuclear science research programs worldwide.

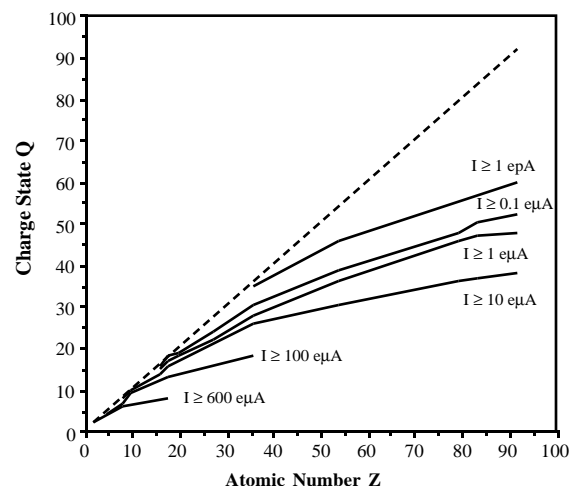


Figure 1. Present cw performance of ECRISs at various intensity levels as a function of atomic number up to uranium.

## Footnotes and References

\*Condensed from two invited review papers presented at the 7<sup>th</sup> International Conference on Ion Sources, Taormina, Italy, Sept. 1997, and the 1997 Particle Accelerator Conference, Vancouver, BC, Canada, May 1997.